

# SCIENCE

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## THE TECHNICAL SCHOOL AND THE UNIVERSITY.

DURING the past four hundred years there has been a most significant although gradual development in the university organization. This has been a necessary result of the evolution of knowledge. The earliest continental universities found a reason for their being in the dissemination of a system of scholastic learning which had little to do with the affairs of men. A body of learning based chiefly if not wholly upon certain conventional systems of abstract knowledge like the Aristotelian logic, transmitted with little or no change from the masters of antiquity, constituted essentially all they had to offer to their students. The instruction consisted almost entirely of certain exercises in this intellectual inheritance practically unchanged through the centuries of its transmission. This mental training had essentially no relation to or bearing upon the actual things of human experience, nor had it much effect upon national life or upon any of the varied interests of the community.

In the beginning of the sixteenth century, however, when the dark shadows of the middle ages began to disappear before the illuminating influence of a truer knowledge, a remarkable movement began in a contest which has scarcely been closed to this day. The intense struggle between humanism and scholasticism began in and around the German universities in the early years of the sixteenth century. The

actors in this new culture rejected the old sterile instruction with merciless vigor and displaced it with systems of study touching as closely as possible the actual life of those times. It was their open purpose in which they gloried to treat of things as they actually existed, to get as near to the life of the community as the best knowledge would bring them; in other words, to touch human life intimately and at the greatest possible number of points.

Scarcely had the humanistic movement reached a successful issue, before it was supplemented by the reformation. Although this great religious upheaval was destined ultimately to aid the humanistic movement, an intense struggle marked the first stages of their concurrent development. While the ultimate effects of these two epoch-making movements were virtually the same in their influence upon the advancement of knowledge and upon the evolution of the university, the fundamentally different characters of their two great representatives led to intellectual contests of exceeding bitterness. Fortunately, however, their efforts to advance knowledge along these different lines created a common spirit of true learning, which has been the living stimulant of university life from that day until this.

During the sixteenth and seventeenth centuries the university may be said to have consisted of the philosophical and theological faculties, supplemented by the faculties of law and medicine. The subsequent extensions of the university throughout the eighteenth century resulting from its closer contact with the things disclosed by experience and its widening influence upon all branches of human activity, were chiefly marked by the strengthening of the faculties of law and medicine.

Throughout all this period of over three centuries the philosophical faculty was predominant in its position and influence in

the university. It had come to represent a body of more or less abstract instruction covering by far the greater part of the existing field of human knowledge, and, it must be said, divorced largely from the real things to which it properly belonged. In the early history of universities it constituted a sort of purveyor of privileged or aristocratic learning ostensibly of better birth than the professional faculties of law and medicine, which had the misfortune to deal with the actualities of life on which the welfare and safety of communities no less than the rights and duties of individuals are fundamentally based. This conventional class distinction constituting a kind of snobbery of learning was the real influence or force so completely overcome by the movements of humanism and the reformation, and it has bequeathed to us the useless and senseless term 'pure' science as opposed to applied science; as if there could be in some way a science politely distilled as an essence of learning separated from the realities with which absolutely all science whatever has to deal and without which no science whatever can exist. A mere scholastic philosophy based upon the sterility of bare convention and authority was displaced by an honest and fearless search for the real knowledge which lies at the base of all true learning. The deadening influence of prescribed knowledge gave way to the quickening stimulus of individual power and freedom of investigation in every field of experience. All the professional schools of the university, prominent among them being the modern technical schools, are the fruitful products of this ever increasing and abundant intellectual life.

During the latter part of the eighteenth and throughout the nineteenth century the extensions of all branches of physical science so enlarged their fields of application that the foundations were laid of an-

other distinct and prominent faculty. The great investigators in chemistry, in physics, in biology and in the marvelous combinations and ramifications of those and other affiliated sciences were the pioneers in the service rendered by science to the creation of the industries of the world which have been such potent agents in the extraordinary advancement of civilization during the past one hundred and fifty years. Every addition to scientific knowledge, meaning simply a closer contact with the realities of our natural environment, has supplied a corresponding field of activity for useful effort and in just that much has enlarged the meaning and the volume of life.

All these practical or useful extensions of technical knowledge have in fact been made possible by the technical work of the university, although many of the greatest investigators and of those who have been most successful in enlarging useful production have received their individual stimulus and prosecuted their life work outside of the university organization. The university has been the nursery of useful scientific investigation and the influence of its instruction has extended with an ever-increasing acceleration far beyond the limits of its immediate environment. The practise of every technical profession is founded upon precisely that quality and kind of knowledge established by investigation and by instruction at those centers of learning which only have been the originators and transmitters of useful knowledge from the earliest beginnings of science to the present day. Although there has been much scientific investigation and remarkable applications of science to human activities by individuals or in communities, to whom apparently even the meaning of university work was unknown, the fundamental principles on which the value of the subsequent technical work is wholly

based will be found in practically or absolutely all cases to have germinated in the fertile soil of the university.

The initial stages of technical education took form first in the universities of Europe. The subsequent development of that educational work into complete technical faculties is found to have been practically concurrent in the universities of both Europe and America, although the former have precedence in time over the latter by comparatively short periods. These faculties have not always been known by the names of the professional practise for which it is the purpose to prepare their students, but the apparent defect in the continuity of the case is not real. In the earliest university courses of technical study instruction was given in a substantial number of technical subjects under a faculty of broader jurisdiction than that confined to a technical profession, and in some of them that method is pursued even at the present time. Such courses of study effectually answered their purpose in the early days of the engineering and allied professions, but their administration has generally been advanced by a natural development concurrent with the growth of the professions which they have served, to remarkable groups of technical faculties of such prominence and intellectual strength and with such numbers of students as almost to dominate the true university in some cases, and even to form essentially technical universities in others.

These great technical faculties have been the direct results of the dissemination of knowledge by the university. Even the professor who has boasted that he never wittingly either learned or taught anything useful has been the servant of real learning by extending the limits of scientific knowledge which refuses to be hindered or circumscribed by its narrowest and most erratic votaries. Wherever there

has been a seat of learning, from that point has issued a quickening influence which has stimulated the growth of every form of useful activity. All the great industries on which the prosperity of every civilized nation is based, have originally sprung from the small beginnings which had their initial impulse from some branch of knowledge, acquired in the first instance at the university.

So closely are all forms of knowledge related in their fundamental elements that no one of them can attain to a state of real growth without carrying others more or less with it. This elementary principle which finds illustrations and the most conclusive proof in every field of educational experience underlies the fundamental organization of the university, and it completely justifies the place of the technical school in the university plan. Further than that, it illuminates in a clear and instructive manner the natural development of the institution of universal learning.

The ramifications of every branch of science reach a great variety of human interests many of which are directly affected by it, while others are more remotely touched. The full significance of every acquisition of knowledge can only be understood or even to a small degree appreciated by realizing the industrial activities or other real interests of the community which it affects. An isolated study of any one technical subject, or of any other subject, without regard to its relation to other branches of knowledge, would be excessively narrow in its results and probably as valueless as narrow, if indeed such a study be not unthinkable. The greater the number and scope of scientific or technical subjects brought within the range of instruction, the broader will be the whole amount of knowledge acquired, and the more complete and thorough will be the comprehension of any one of them.

There is a limit to the number of subjects which can profitably be taken by any student in a course of proposed study, but there can be no question whatever that the instruction in any one subject will be enhanced in value in proportion to its breadth, or its reach into other and related or affiliated subjects.

The more complete the view of the field covered, the more satisfactory will be the student's work in it. In fact, it may be stated that the real study of any one part of the field of knowledge consists in acquiring information relating to its effect upon other fields into which it reaches. It is impossible to conceive of any subject of scientific study as an abstraction either from other subjects or from the material elements of experience.

The bearing of all these considerations on the place of the technical school in the university is most direct and essential. In the first place the instruction in any professional school of a technical character is an integral part of the whole body of instruction belonging to an institution of universal learning. It can not be given so effectively anywhere else as in the organization of which it forms a part absolutely necessary for completion.

The advantages gained by a technical school in a university environment are fundamental; they touch both its technical work and the general educational training which must precede the technical in any adequate course of study of a professional character. An engineering or other technical student pursuing his work in a university system finds himself in a stimulating atmosphere of study and investigation reaching far beyond the limits of his own field. He acquires largely by incidental or even unconscious absorption a broad cultivation by constant contact with active educational work, some of which is more or less affiliated with his and some

not. This association is an inspiration to a broader and more enthusiastic view of his own work in itself as well as a material enhancement of value of that work by disclosing its relations to other fields of learning, all impossible to attain outside of the university. These conditions give his educational training qualities that not only strengthen them and widen his subsequent professional practise but contribute most effectively to his intelligence and usefulness as an educated citizen.

More than this, the technical professions now demand of their members for the higher planes of successful practise the same general educational preparation for professional study as that required by the best law and medical schools. Without entering into a discussion as to the relative merits of the educational work done by the small college and by that forming a subordinate member of the university, it is sufficient to say that this part of a well-rounded course of professional study harmonizes completely with the university system and is in fact an essential element of it.

Both for technical efficiency, therefore, and for the broadest and best educational motives the technical school is bound to find its strongest development in an environment of universal study and investigation.

The university has long since lost the character, if it ever properly had it, of a place where abstractions of learning, separated from the things which only give them life, are to be dispensed after the manner of instruction to men who are never to deal with the affairs of life. It has come to be an intensely practical working agent. It is effective and worthy of support only in so far as it makes itself felt in the real life of the community. If it is to be a true and real center of instruction it is imperative that it shall carry knowledge

into every useful calling, governmental, corporate or private. The time will soon come, if indeed it is not already reached, when it only can prepare men to administer and extend in a rational and moral way the great industrial activities which at the present time form the foundation of the material prosperity of the modern world.

The true student of the professional or technical school becomes heir to a comprehensive and clear understanding of his duties and responsibilities in his relations to his fellow men and to the community. Those duties and responsibilities present themselves to his trained mind in their real proportion. He is neither non-developed nor mal-developed in his judgment of affairs. His university training, especially in the technical school, has taught him accuracy and penetration in the analysis of any proposition confronting him, and that truth and knowledge must be sought with the directness of a plumb line. Science yields nothing but confusion to the shifty, devious and dishonest inquirer. The fundamentals of morality are the very stepping stones to technical success or professional attainment.

The opportunities offered in the administration of public affairs and the great corporate interests of the present time, rapidly increasing in number and magnitude, create almost irresistible temptations to prostitute them to selfish gain. The realization that great power, or what has now come to be its full equivalent, great wealth, is a grave and delicate trust, to which selfish gratification in its infinite and seductive variety is abhorrent, comes most naturally and easily through sound knowledge 'the beginning of wisdom.'

The correct conception of his duties gives to the professional man such a deep and true sense of his responsibilities as to render him the safest administrator of those great interests whose sinister power

has already threatened both the morals and the safety of the community. Selfish gratification is a temptation to which he may or may not yield, but his inheritance from the university translates wealth to be a means of accomplishing the highest means of life, and saves him from that narrow, common complaisancy of wealth which is the dry rot of character.

In this age of self-appointed erratic and dangerous regulators of society when an unreasoning and destructive discontent frequently prompts to crude measures whose real purpose is a blind upheaval of the existing order of things, the intelligence and the calm balance of the university man of affairs must be the corner stones of public safety. His trained mind taught to analyze and to test by the records of experience no less than by the precepts of science does not lose its poise before either the shallow plausibilities of the advocate of Utopia or the sinister deceptions of the revolutionary reformer or what has come to be nearly as bad, by the egoistic and blundering although much-applauded strenuosity of the present time. It is not to be supposed for a moment that every subject of university training will issue from its halls the ideal well-rounded citizen but judgment must be passed upon such matters in view of their resultant tendencies. A fair and careful scrutiny of the impress made through the professional schools of the university, from the older faculties of philosophy and theology to the modern faculty of engineering, upon the broad moral, governmental, professional and business affairs of the most cultivated communities of the world, conclusively confirms and supports these observations.

The creative or evolutionary influence of the university upon the community is exercised chiefly, and it will ultimately be exercised entirely, through its professional faculties, its faculty of philosophy already

having become essentially a professional faculty of teaching, a character which it is bound fully to assume hereafter. This is the highest and ultimately the complete mission of the university. This means with absolute certainty that professional instruction shall be given not by closet professors, but by men who are students in the highest and best sense of the word, profound students not only of the abstract principles of their profession, but of the play and power of those principles upon the affairs of men. This knowledge must be gained by taking their full part in human experience and not by withdrawing from it. Their investigations must be made largely in the practical operations of their professions. In other words, they must be men of affairs as well as students. A living and forceful quality can be given to instruction in no other way whatever but by actual contact with the things encountered in practical experience and precisely in the relations disclosed by that experience.

Some of the professional faculties have already benefited by this quickening and energizing influence of living contact with their professions. The medical faculties are composed largely of eminent practitioners and it is not too much to say that it would be impossible to give the requisite instruction were it otherwise. It is well known that most serious defects in the present educational administration of the university faculties of law and engineering are due to the fact that too many instructors fail of that true development and broad training gained only by actual professional experience. It may be confidently stated that instruction in professional engineering subjects can not now be given with the necessary breadth and efficiency without supplementing the imperatively necessary work of the study by extended practical experience. And those ob-

servations are not peculiar to the faculties to which they are applied. The time has already come when the professional faculties, and preeminently so those of the technical schools, must be active, living parts of their professions. There is no other way by which they can either properly discharge their own functions or become members of a university organization strengthened and equipped to meet its wide educational responsibilities which make it one of the greatest conserving and elevating forces of the community.

The technical schools constituting the great modern professional schools of the university are integral parts of it and necessary consequences of its natural evolution. They belong to it historically and naturally. They are professional schools, and professional schools not only belong to the university, they are the university.

WILLIAM H. BURR.

THE AMERICAN ASSOCIATION FOR THE  
ADVANCEMENT OF SCIENCE.

SECTION I—ECONOMIC AND SOCIAL  
SCIENCE.

THE address of the retiring vice-president, Professor Fisher, on 'Economic Science,' was followed by an address of welcome by Professor Frank A. Fetter, ex-secretary of the American Economic Association, in which the work of the section was commended for its services in emphasizing the scientific method in economics in contrast with the conception which gave most attention to theoretical discipline.

The discussions of Professor Norton's paper (see below) by Dr. W. H. Welch, of Johns Hopkins, and Dr. A. C. Abbott, of the Philadelphia Board of Health, added materially to the value of this session. Dr. George W. Kober, of Washington, and Fred. L. Hoffman, of Newark, sent communications on this paper, the

<sup>1</sup> See SCIENCE, August 31, 1906.

latter especially criticizing the proposals relating to federal control of medical institutions.

*Economic Advisability of a National Department of Health:* PROFESSOR J. PEASE NORTON, Yale University.

The salvation of the civilization and the race lies in the hands of exceptional men. The hope of the race inheres in their efficient organization for action. Organization consists in compelling voluntarily or involuntarily each individual to do that thing within his capability which has greatest value for society. To do otherwise is a great waste. To permit great wastes to go unchecked is more than a suicidal policy; for an evil more heinous than race suicide is race homicide.

There are four great wastes to-day, the more lamentable because they are unnecessary. They are preventable death, preventable sickness, preventable conditions of low physical and mental efficiency and preventable ignorance. The magnitude of these wastes are testified to by experts competent to judge. They play their part in a cruel devastating destruction that is almost incredible to the human mind.

The economic reasons for establishing a national department of health are five: (1) To enable society to progress more rapidly under the law of increasing returns through increasing the per cent. of exceptional men of each degree (many of whom are now lost through preventable accidents), in addition to increasing the total population. (2) To lessen the burden of the unproductive years on the productive years by increasing the average age at death. (3) To decrease the burden of death on the productive years by increasing the age at death. If the expenses of illness and death are \$300 and the average age at death is forty years, the average death expenses average \$15 on the twenty